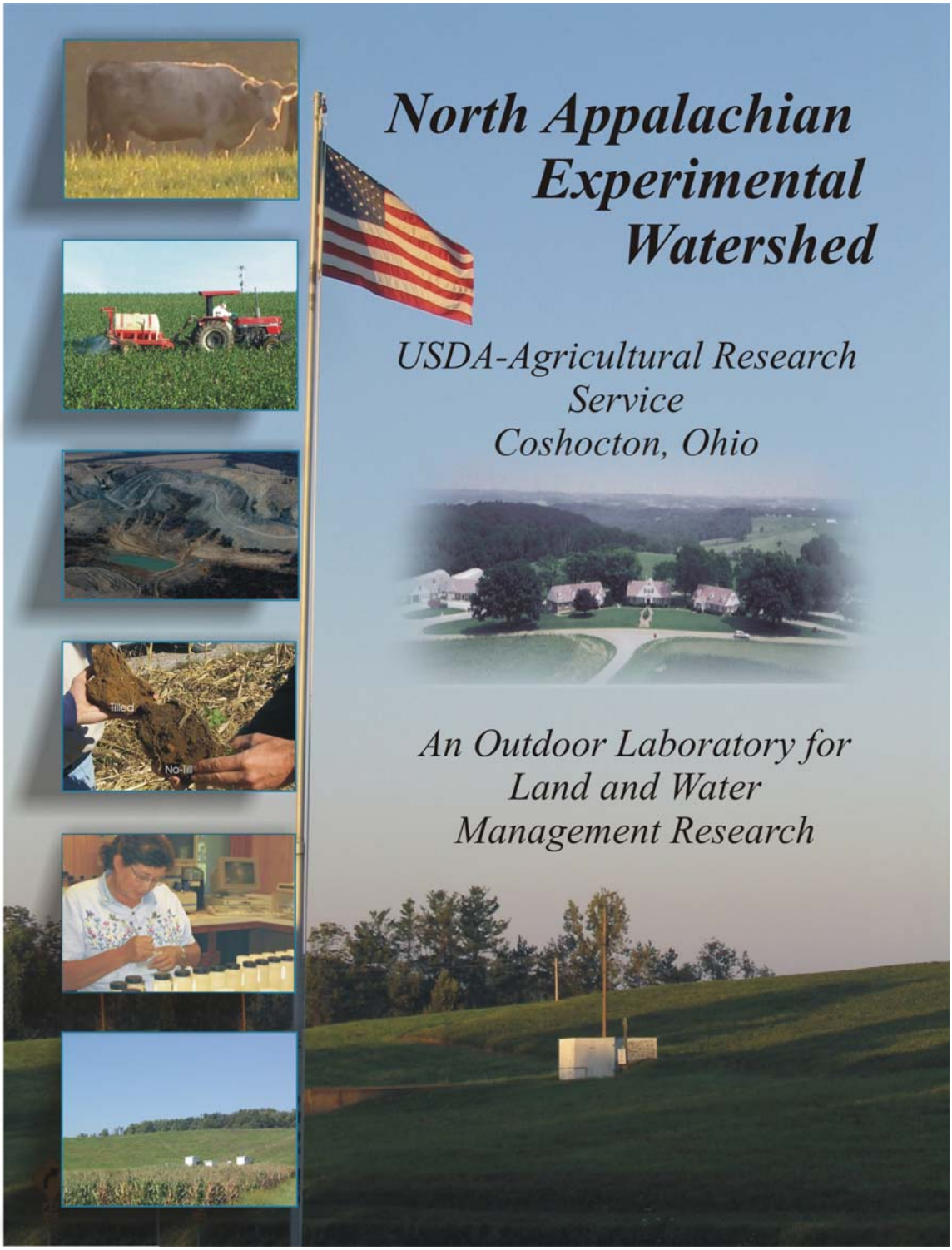

USDA – Agricultural Research Service
North Appalachian Experimental Watershed
Coshocton, Ohio
An outdoor laboratory for land and management research

July 2005

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North Appalachian Experimental Watershed (NAEW)
Coshocton, Ohio

The NAEW is a world-class hydrological research facility for investigating the impact of land management practices on environmental quality. It is located near Coshocton, Ohio where the soil, climatic, and geologic conditions are representative of major portions of Indiana, Kentucky, Ohio, Pennsylvania, Tennessee, and West Virginia. The NAEW is maintained by the USDA-Agricultural Research Service in collaboration with The Ohio State University/Ohio Agricultural Research and Development Center. A wide variety of land management practices have been investigated in response to the environmental issues of the day since the NAEW was established in the mid-1930's. The issues investigated range from the effects of crop and pasture management to the effects of surface mining and land application of industrial, municipal, and agricultural wastes. The land management practices, data, models, and measurement techniques developed and refined at the NAEW are used throughout the world. Global climate change and carbon sequestration are a major focus of current research efforts.

Resource overview:

- More than 1000 acres of government-owned land
- 22 instrumented watersheds for surface runoff studies ranging in size from 1 to 300 acres with land available to install additional watersheds
- 11 large (1/500 acre), monolith, lysimeters for ground water and evapotranspiration studies
- Complete meteorological station and network of recording rain gages
- 60+ year, computerized, database of runoff, climatic conditions, and soil properties
- Experienced, on-site, staff of technicians and PhD scientists
- History of collaboration with other ARS laboratories, universities, and other government entities

Current research:

- Investigation of the effects of global climatic change on precipitation variability
- Quantification of the effects of land management on the fate of soil organic carbon and carbon sequestration
- Development and evaluation of Best Management Practices (BMPs) for crop and animal production that improve soil, air, and water quality
- Evaluation of the effects of urbanization on soil and water quality
- Impact of using paper mill sludge as a reclamation aid on surfaced mined lands
- Effects of management intensive grazing on soil and water quality

Capabilities:

- Ability to quantify the effects of land management practices on water, air, and soil quality at realistic, watershed/production scales
- Experienced field, laboratory, and scientific staff with a proven track record of modifying existing techniques or developing new ones to investigate environmental monitoring challenges
- Demonstrated ability to investigate the environmental impacts of surface mining and usage of agricultural, industrial, and municipal byproducts as soil amendments as well as a history of carbon sequestration research

Coal Surface Mining and Reclamation Studies

Surface mining and reclamation activities drastically disturb large areas of land during coal extraction. However, little was known about the effects of these drastic land disturbances on hydrology and water quality prior to enactment of surface mine reclamation laws. Quantitative estimates of the magnitudes of watershed-scale runoff, and chemical and sediment concentration changes in streams and in ground water were lacking. Furthermore, the effectiveness of reclamation practices to reduce sediment and chemical loads were undocumented.

Scientists at the North Appalachian Experimental Watershed (NAEW) initiated a 9-year, $3 million project with three mining companies, other agencies and The Ohio State University to investigate the watershed-scale effects of drastic land disturbances due to coal mining on hydrology, water quality, and sedimentation. The NAEW was chosen because of scientific and technical expertise in conducting watershed-scale research. In order to obtain a complete picture of the effects of land disturbances due to mining, stream and ground water in watersheds in the coal fields of southeast Ohio were monitored in their unmined, natural state, during mining and reclamation operations, and after reclamation. The project resulted in a number of technical publications and reports covering ground water hydrology and water quality, surface water hydrology and water quality, and sedimentation, and has helped regulatory agencies and mine operators. Among the many results from this study, it was found that sediment and chemical loads, and runoff significantly increase during mining, and can remain elevated after reclamation. Proper reclamation practices can reduce sediment concentrations and loads to below pre-mine levels. It was also found that the watersheds were continuously changing during the five-year reclamation period. This is a one-of-a-kind study and provided crucial baseline data on stream hydrology and water quality data for evaluating the long-term effects of mining and reclamation.

Paper Mill By-Products on Mined Lands

More recently, the NAEW has initiated a project in collaboration with the paper industry, Ohio EPA, and ODNR to investigate the land application of paper-mill byproducts on reclaimed mined land. Land-applied paper-mill byproducts appear to provide a good medium for plant growth and significantly control erosion in the unprotected slopes of mined areas. However, questions remain about safe application rates and methods to utilize the byproducts to protect downstream waterways.

Capabilities for Continued Mine-Related Research

Increased mining for coal in Ohio and surrounding states will require additional research to minimize the impacts of mining and reclamation on runoff, and sediment and chemical loads to streams. The strong technical and scientific expertise and history at the NAEW in monitoring mined and reclaimed watersheds for runoff and water quality makes the NAEW a valuable asset for the FutureGen project.

Carbon Sequestration Research

Greenhouse gases and global climate change have become major, current topics. Much of the greenhouse gas discussion has dealt with carbon dioxide (CO_2) and methods to sequester or store atmospheric carbon. To better understand the overall process, the entire carbon cycle needs to be studied. The major carbon transformations are loss of CO_2 to the atmosphere or the storage of carbon in sinks such as the soil.

The carbon sequestration research at the North Appalachian Experimental Watershed (NAEW) has focused on assessing the impact of land use management on the level of carbon in soil, the practices that favor sequestration and the practices that cause carbon loss.

Tillage is detrimental to the storage of soil organic carbon (SOC).

- No-till practices for row crops not only reduce surface runoff and erosion, but have SOC levels similar to soils under meadow.
- No-till practices plus an organic amendment such as manure measurably increase SOC above the levels in soils under meadow or no-till without organic amendment.
- One year of conventional tillage (moldboard plowing with disking) mixes the SOC in the plow layer but may not decrease the total SOC by a measurable amount.
- Multiple years of annual conventional tillage causes measurable loss of SOC.

SOC loss by erosion is best addressed by proper management selection.

- SOC concentrations on sediments from different conservation tillage practices on small watersheds were similar.
- Sediment losses varied with different practices, and SOC transport varied accordingly.
- SOC losses via sediment could be reduced by selecting a practice to reduce sediment, not by looking for a practice to reduce concentration of SOC on sediment.

Carbon losses by leaching through soil and into ground water is a minor pathway.

- SOC concentrations in water from developed springs in pastures were low, ranging from 1 to 3 mg L^{-1}.
- SOC concentrations in water coming out of the bottom of large soil blocks, called lysimeters (0.002 acres by 8 feet deep) planted in a corn/soybean rotation were in a similar range, 1 to 3 mg L^{-1}.

Continued carbon study capabilities

Various industrial byproducts, including byproducts of power generating plants, may have agricultural benefits as fertilizers or soil amendments. There is strong technical and scientific expertise at the NAEW, as well as laboratory facilities, to assess impacts of fertilizer and soil amendments on direct or indirect carbon sequestration.

Fertilizer and Water Quality Research

High nutrient levels in surface water and groundwater can create environmental problems by promoting excessive algal growth. The death and decomposition of the algae depletes oxygen in the water and can kill other aquatic life, e.g. fish kills. This same process is involved in creating the "oxygen free" dead zone in the Gulf of Mexico ("hypoxia"). Nitrogen and phosphorus are the two main nutrients of contributing to this condition. The maximum contaminant level for NO_3-N is 10 ppm. Reduction of these nutrients in water decreases the detrimental environmental impacts, and lower levels of N in water lessens the expense of water treatment.

Although there are several sources for these nutrients that enter surface water, fertilizers are a main contributor. The main focus of water quality research at the North Appalachian Experimental Watershed (NAEW) has been studying the movement of nitrogen into groundwater and via surface runoff with various management practices, but other nutrients have been assessed also.

Nitrogen (N) movement in surface runoff

- The greatest potential for N loss is when surface runoff occurs within a few days following fertilizer application. The shorter the time between fertilizer application and runoff the greater the loss of N fertilizer and subsequent detrimental impact on water quality. This has been noted for pastures as well as for row crops.
- Management practices that reduce surface runoff will reduce fertilizer losses via runoff.
- More stable formulations of N fertilizer will have lower gaseous N losses.

Nitrogen movement via groundwater

- Most N movement via groundwater occurs during the late winter/early spring in the period of soil moisture recharge.
- Excess N fertilization contributes to N leaching. Excess N fertilizer may result from fertilizer being applied in excess of crop needs or from poor plant growth, e.g. resulting from floods or drought.
- To avoid excess N for pastures, annual fertilizer rates should be 100 lbs per acre or less. All sources of N (fertilizer, manure, legumes) should be included in the calculations.
- Without the animal component in the system, hay fields may have higher N recommendations than pastures.

Phosphorus (P) movement

- Most of surface losses of P occur attached to sediment or in surface runoff that occurs soon after fertilizer application. Practices that reduce runoff and sediment loss reduce P losses via these pathways.
- Although losses of P by leaching are often considered to be minimal, high soil P does promote leaching losses of P. Therefore, soil tests are important to determine proper P application rates, and the addition of byproducts (e.g. manure) for fertilization should have rates based on P recommendations and not N recommendations.

Capabilities for continued water quality research

The NAEW has the experimental watershed field and laboratory facilities to continue to study nutrient movement via water and sediment with a variety pasture systems, row crop management practices, and fertilizer/byproduct additions to the management systems.